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Ultimatum decision-making: A test of reciprocal kindness

By

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ABSTRACT

While fairness is often mentioned as a determinant of ultimatum bargaining behavior, few data sets are available that can test theories that incorporate fairness considerations. This paper tests the reciprocal kindness theory in Rabin (1993) as an application to the one-period ultimatum bargaining game. We report on data from 100 ultimatum games that vary the financial stakes of the game from $1 to $15. Responder behavior is strongly in support of the kindness theory and proposer behavior weakly in support of it. Offer percentages and past offers influence behavior the most, whereas the size of the pie has a marginally significant effect on offer percentages. The data is more in support of reciprocal kindness than alternative theories of equal-split or learning behavior, although the data also weakly support a minimum percentage threshold hypothesis. As a whole, our results together with existing studies suggest that, for smaller stakes games, fairness considerations dominate monetary considerations. This has implications for more complicated naturally occurring bargaining environments in which the financial stakes can vary widely.

Keywords: Fairness, Ultimatum Bargaining, Reciprocity, Experiments,

1. Introduction

Fairness, or other-regarding behavior, is frequently mentioned as an explanation for otherwise seemingly irrational outcomes in simple bargaining situations. Ultimatum bargaining has been studied extensively as a means of understanding a building block of more complicated bargaining environments. In the ultimatum game two Players (proposer and responder) bargain over a sum of money. The proposer proposes a division of the sum (or "pie"), and the responder either rejects the proposal, in which case both players receive zero, or the responder accepts the proposal and the pie is divided according to the proposal. If players care only about money then even small proposals should be accepted, but much of the data collected from ultimatum experiments reveals that proposed divisions of less than 50% of the pie are often rejected. Do responders weigh the costs of rejection with the benefits of accepting an offer? Researchers have frequently mentioned the existence of fairness considerations in their explanations of the outcomes of many "pie-splitting" games.[1] While many informal concepts of fairness or kindness exist, economists have only recently begun to incorporate these into their theories.

This paper examines the testable implications of a specific game-theoretic model that incorporates reciprocal kindness into the payoff functions of the bargainers in the ultimatum game. The model used extends from Rabin (1993) as a specific application to the simple ultimatum game experiment of Guth et al. (1982). While researchers in many disciplines point to anecdotal evidence in their search for fairness, limit results derived from the Rabin model allow an experimenter, by altering the stakes of the game, to collect empirical data sufficient to test the theory.

We compare the predictions of the Rabin model to an equal split hypothesis, the minimum percentage threshold hypothesis of Ochs and Roth (1989), and the learning hypothesis of Slonim and Roth (1998). All of these models allow for offers that deviate from the sub-game perfect prediction of a zero offer (and acceptance), but the minimum percentage threshold and learning hypothesis are also consistent with the large body of data in which offers of less than 50-50 splits are made and accepted. We find data in support of the reciprocal kindness model of Rabin, and somewhat more weakly in support of the minimum percentage hypothesis.

2. Fairness Considerations in the Ultimatum Game

The first ultimatum-game experiment of interest is that of Guth, Schmittberger, and Schwartz (1982). To further evaluate whether it is fairness or just fear of rejection that drives ultimatum game proposals, Kahneman, et al. (1986) examine behavior in a variant of the ultimatum game called the dictator game. The dictator game proceeds exactly as the ultimatum game except for the fact that the responders cannot reject the offer. While this can hardly be called a "game," it is of interest that dictators are more willing than ultimatum proposers to offer zero to the other player. We conclude that at least some of the nontrivial offers (e.g., offering a third or half of the pie) in the ultimatum game are merely strategic responses to the tendency of responders to reject any unequal offer. Nevertheless, some dictators still offer nontrivial pieces of the pie, and it shows that concerns for some type of fairness in basic contractual arrangements are well founded.[2] What constitutes "fairness", however, is still in question.

Croson (1996) and Straub and Murnigham (1995) examine how information asymmetries affect ultimatum behavior. Both studies reveal that most bargainers take advantage of information asymmetries and are therefore not "purely" kind. Reciprocity seems to be more supported by data than pure kindness. Reciprocity is studied in Fehr and Tougareva (1995) and Berg, Dickhaut, and McCabe (1995), among others. Fehr and Tougareva find reciprocal behavior even in high stakes games, and Berg et al. shows that trust and social history increase reciprocity.[3]

We can summarize the literature by saying that it is difficult to find experimental results suggesting pure kindness (even the dictator game offers become more self-interested once dictators are made anonymous to *experimenters* as well as to other bargainers: see Hoffman et al. (1991)). More frequently, results suggest that individuals will be fair and kind to those that show them kindness, and unkind to those that show them malice—we will refer to this as reciprocal kindness.

3. A Model of Reciprocal Kindness

Rabin (1993) incorporates fairness into a game theoretic model using a "kindness" function. Bolton (1991) presents a somewhat similar theory in which 2-period bargainers gain utility from both absolute money and relative (to other bargainer) money. The predictions of Bolton are qualitatively similar to those of Rabin in terms of Ultimatum bargainers, but here we develop the application of the Rabin theory since it is structurally simpler (e.g., only one period and no discount factors to consider). Both models, however, give the sense that strategic fairness drives behavior.[4] The basic idea in Rabin is that utility is described as a function of both monetary payoffs as well as a kindness payoff that is determined by a kindness function. See Rabin for a complete description of the formal strategy space. The kindness function of player i is defined as

$$f_i(a_i, b_i) = \frac{\pi_j(b_j, a_i) - \pi_j^e(b_j)}{\pi_j^h(b_j) - \pi_j^{\min}(b_j)} \tag{1}$$

where a_i represents the strategy of player *i*, b_j represents the strategy that player *i* believes player *j* is playing, and $\pi(\cdot)$ represents payoff pairs. The superscripts *e*, *h*, and *min* denote the equitable payoff (a 50-50 split), the high payoff, and the minimum payoff, respectively, from among Pareto-efficient payoffs. This function expresses the kindness of player *i* towards player *j* as the payoff that *i* offers *j* minus the "equitable split" payoff, all divided by the difference between the high and low payoff that *j* could receive among Pareto-efficient payoffs. Player *i* has a similarly defined function for his *belief* of how kind player *j* is being to him, denoted $\tilde{f}_j(b_j, c_i) = \dfrac{\pi_i(c_i, b_j) - \pi_i^e(c_j)}{\pi_i^h(c_i) - \pi_i^{\min}(c_i)}$, where c_i is player *i*'s belief about what strategy player *j* believes that player *i* is playing. Rabin keeps the two functions notationally distinct, but formally they are equivalent. Each player *i* then chooses their strategy a_i to maximize his expected utility, which is described as a combination of monetary payoffs and payoffs resulting from a shared notion of kindness,

$$U_i(a_i, b_j, c_i) = \pi_i(a_i, b_j) + \tilde{f}_i(b_j, c_i) \cdot [1 + f_i(a_i, b_j)] \qquad (2)$$

Here, the driving feature of preferences is that reciprocal kindness or reciprocal malice improves an agent's utility. The formal definition of a fairness equilibrium is then described as *Definition* 3 in Rabin.

> *Definition* 3: The pair of strategies $(a_1, a_2) \in (S_1, S_2)$ is a *fairness equilibrium* if, for *i*=1,2, $j \neq i$,
>
> (a) $a_i \in \arg\max_{a_i \in S_i} U_i(a_i, b_j, c_i)$
>
> (b) $c_i = b_i = a_i$

This defines the equilibrium for a psychological game in which higher-order beliefs must match actual behavior.[5]

The ultimatum game is sequential, but each player moves only once. The only other difference with Rabin's theory is that the responder receives an *actual* signal of kindness as opposed to forming a belief about the kindness signal.[6] The implication is that the responder's utility function as described in (2) will incorporate actual kindness as opposed to the perceived kindness shown by the proposer. While the responder's utility function is formally different, the conditions for the fairness equilibrium are the same. This is true since conditions (a) and (b) in Definition 3 must still hold, and condition (b) is now trivially satisfied for the proposer (i.e., the proposer's offer (strategy) is seen and the responder need not form a belief of this offer (strategy)). In other words, the assumption of a nonsequential game is violated, but the basic equilibrium description is still the same except that higher-order beliefs must only match actual behavior with respect to what the responder's strategy is.[7]

A minor alteration to Rabin's theory that we use includes different weights on monetary and kindness payoffs for different individuals. This type of weighted utility model, as well as Rabin's model, assumes constant marginal rates of substitution between monetary and nonmonetary payoffs. The weighted utility model is, however, more general in that it allows for different individuals to weight their satisfaction from money and fairness payoffs differently. Our utility function that extends from Rabin is then

$$U_i(a_i, b_j, c_i) = \alpha_i \pi_i(a_i, b_j) + (1-\alpha_i)\tilde{f}_i(b_j, c_i) \cdot [1 + f_i(a_i, b_j)] \quad \text{where } 0 \le \alpha \le 1 \tag{3}$$

This weighting allows for a wide variety of preferences. The polar cases are the individual that cares only about monetary earnings (α_i=1) and the individual who cares only about reciprocal kindness earnings (α_i=0).

4. Application to the ultimatum game

Notice that equation (3) implies that any *single* outcome can be supported as a fairness equilibrium given a certain weight α.[8] However, this does **not** imply that testable implications do not exist, and in this section we highlight the testable limit-property implications of the model. As an application of this fairness equilibrium, let us look at the typical $X ultimatum game. Here, let X be the size of the pie, and Y be the proposer's offer to the responder (hence, the proposer would keep X-Y). The proposer's kindness function in the ultimatum game is then

$$f_1(a_1, b_2) = \frac{Y - X/2}{X} \in \left[-1/2, 1/2\right] \tag{4}$$

If the proposer offers 0, then the responder cannot feel kindness towards the proposer and so he rejects and the game is over. What is of real interest is when the proposer offers Y>0. Then the responder should accept when the utility of doing so is greater than the utility of rejecting the offer. The utility to the responder (player 2) of rejecting is

$$U_2 = \alpha \cdot 0 + (1-\alpha) \cdot \left(\frac{Y - X/2}{X} \right) \cdot \left(1 - \frac{1}{2} \right) \quad = \frac{(1-\alpha)Y}{2X} - \frac{(1-\alpha)}{4} \tag{5}$$

whereas the utility to the responder of accepting is

$$\begin{aligned} U_2 &= \alpha \cdot Y + (1-\alpha) \cdot \left(\frac{Y - X/2}{X} \right) \cdot \left(1 + \frac{(X-Y) - X/2}{X} \right) \\ &= \alpha \mathrm{Y} + \frac{2Y(1-\alpha)}{X} - \frac{(1-\alpha)Y^2}{X^2} - \frac{3(1-\alpha)}{4} \end{aligned} \tag{6}$$

The condition is then that the responder will accept the offer when utility from (6) is greater than utility from (5), or

$$r^2(1-\alpha)+r\left(\frac{(1-\alpha)}{2}-2(1-\alpha)-X\alpha\right)+\frac{(1-\alpha)}{2}\leq 0 \tag{7}$$

where $r = Y/X$ is the responder's share of the pie. The following limit properties are calculated from (7):

a) as $r \to 0$, holding X fixed, the responder will tend to reject offers.
b) as $r \to 1$, holding X fixed, the responder will tend to accept offers.
c) as $X \to \infty$, holding r fixed, the responder will tend to accept offers. This result is also mentioned in Rabin (1993). It states that as the size of the pie gets arbitrarily large, the responder is less likely to reject a given percentage offer since the monetary penalty for doing so grows increasingly large.
d) as $\alpha \to 1$, the responder will tend to accept offers.

These limit results are intuitive and suggest that this fairness model is a reasonable game-theoretic way of describing the ultimatum game.[9] Bolton (1991) includes some similar limit results for a two-period bargaining game but mentions that there is little relevant empirical data in this area.[10]

If we divide the condition for acceptance in (7) through by $r(1-\alpha)$, we can write

$$\frac{\alpha}{(1-\alpha)}X \geq r+\frac{1}{2r}-\frac{3}{2} \tag{7'}$$

This way of expressing the condition for acceptance is of value since it lends itself to a nice graphical representation of the acceptance condition shown in Figure 1. From (7') the limit results above are perhaps more obvious as well. In Figure 1 we notice that an offer of zero will always be rejected while the responder should always accept an offer of more than 1/2 the pie. It is when the offer is between 0 and 1/2 the size of the pie that the relevant parameter is the relative weight placed on money payoffs multiplied by the size of the pie X. Notice also that, among the four limit conditions listed above, the experimenter can manipulate the stakes of the game—condition (c).[11] The following section on the Experimental Design discusses how we handle the fact that that the ratio r cannot be literally held fixed in (c).

FIGURE 1 HERE

What should be highlighted from the above exposition is the following: Offers and acceptances/rejections by themselves offer no power to test the theory. *Any* offer and acceptance/rejection can be supported as a fairness equilibrium depending on the weights that individuals place on monetary and kindness payoffs and the size of the pie.[12] Among the propositions in Rabin are that kindness payoffs dominate utility for small pies and monetary payoffs dominate utility for larger pies. We cannot, however, know what constitutes a "small" or "large" pie for a given individual. In order to test this theory then, the only option left is to explore the limit results.

Another way to look at what is represented in Figure 1 is in terms of expected utility maximization subject to constraints. Figure 2 shows how the constraints would look for the proposer of ultimatum games of size X=$10, X=$5, and X=$1. If acceptance of any offer were guaranteed, then the constraints would be continuous in the money-kindness space with a slope

FIGURE 2 HERE

of -1/X, representing the game's tradeoff rate between kindness and money. However, the possibility of rejection implies a discontinuity in the expected constraints. If R(X) represents the rejection point of the respondent for a game of size X, then all offers<R(X) in terms of kindness will be rejected and both individuals earn zero. Limit result (c) is then reflected in Figure 2 by noting that a responder is willing to accept less kindness as the size of the pie grows. The

decision seems quite simple for the responder who essentially behaves under certainty. The proposer, on the other hand, must form an expectation of R(X).

Preferences as described by equation (3) can be represented by linear indifference curves in the money/kindness space of Figure 2. Such linear indifference curves assume a constant marginal rate of substitution between money and kindness. The slope of the indifference curves is determined by the relative values the proposer places on money and fairness, that is, α and $(1-\alpha)$. It is clear from Figure 2 that if the proposer places a high enough value on kindness (small α), then the utility maximizing choice would be the corner solution of the game where the proposer offers the entire pie to the responder, who then accepts. Of course, this is rarely an outcome in ultimatum games. More likely, the proposer cares enough about money earnings such that the utility maximizing choice would be the last point on the constraint before the responder rejects. In the event that the proposer's preferences represented the same tradeoff rate between money and kindness as the slope of the game's constraint, then any choice on the constraint where kindness>R(X) would be utility maximizing.[13]

5. The Experimental Design

The design presented in this section is aimed at studying whether or not outcomes in the ultimatum game are in fact consistent with the specific model of reciprocal kindness extended from Rabin (1993). This experiment involves playing 5 different ultimatum games (5 rounds)--where X=$1, $2, $4, $7, and $15. These would typically be classified as low stakes games, but the stakes are nonetheless varied by a factor of 15. Cameron (1995) and Slonim and Roth (1998), among others, vary the stakes of the ultimatum game by factors of 40 and 25, respectively, where the stakes were as high as 62 hours of wages (Roth and Slonim). Rabin’s hypothesis is that for smaller stakes, kindness payoffs will dominate money payoffs. While we do not contend the fact that these stakes are not the largest that exist in the ultimatum literature, the student subjects employed were still bargaining for amounts that would total well over the opportunity cost of their experimental time (about 45 minutes—the average experimental payoff was almost $13).

The order in which the games are played is randomized. After each ultimatum game, partners are switched so that a proposer (responder) is never matched with a responder (proposer) more than once. Responders (proposers) always remain responders (proposers).[14]

The information environment of the design is somewhat peculiar and should be explained. Both responders and proposers know that the size of the pie will vary from round to round, but they do not know whether it will increase or decrease from any one round to the next. Subjects also know that they will never be matched with the same individual more than once and that they will never know the identity of the person with whom they are matched in any round. Proposers, however, are given an additional piece of information: The proposers, starting with round 2, are given information on what the responder *with whom they are currently matched* did in the previous round. Specifically, they are informed on a piece of paper what the responder was offered, what the pie size was, and they were also told whether or not the responder accepted or rejected the offer. The proposers also know that the responders do not know that they have been given this information. There is no deception involved at all. One group of subjects is merely told something that the other group is not told.

The purpose of creating this information asymmetry is the following: The only way in which the offer of a proposer can test the kindness theory is if he can make a calculated response to the changing size of the pie. One option is obviously to not rematch subjects, and in this way a proposer makes different offers to the same responder for different-sized pies. This, however, leads to subjects playing a multi-stage game instead of the desired one-stage game. In order to avoid the play of a multi-stage game, the subjects are rematched in each round. However, if subjects were merely rematched without giving the proposers the additional information described above, then the lack of this information would imply that no offer in any stage game can be compared to any other offer in any other stage game because a different responder in each game means that the proposer faces a new Figure 1 for each game. The percentage offer by a proposer may change, but any comparison would be meaningless since the responder changed also (e.g., the first responder may have a very convex Figure 1, while the next responder a proposer is paired with may have a more straight-line Figure 1, thus confounding any comparison between offers).

With the design used here, the proposer makes an offer knowing whether or not last period's offer was in the accept or reject region of that responder's personal Figure 1. This information asymmetry is required for a good test of Proposition 2 (given below), even though the asymmetry is not part of Rabin's model. This author was unable to come up with a design which would avoid the asymmetry while also avoiding a multi-stage game, a set of entirely unusable data, or the need to make additional assumptions on players' utility functions.

Such a comparison still places bounds on what the proposer would do to behave in accordance with the kindness theory. In other words, it does not so much matter that the proposer might or might not have made *that particular* offer (if he had been matched with that responder in the previous game), but that he can respond to what he believes is the specific Figure 1 from which the responder is making decisions. Finally, responders were not told of this information disclosure since pilot experiments revealed that when responders knew this they would engage in reputation building.[15]

5.1 The Predictions of Reciprocal Kindness

By referring back to Figure 1, we can more precisely define the bounds on behavior consistent with the kindness theory. For the responder, it is clear that if an offer r is accepted for a given pie X, than any movement northeast (NE) on Figure 1 should also be an acceptable offer. A rejection would violate the theory. Any other movement (SE, NW, or SW) may or may not be accepted depending upon the size of the change in either X or r and therefore does not violate the theory—a stronger test of the theory might rule out such observations as inconclusive. Similarly, if an offer r is rejected for a given pie X, than any movement SW on Figure 1 should also be rejected (an acceptance would violate the theory). This is our Proposition 1

-*Proposition 1 (for the responder)*

Case 1-Comparison to an accepted offer

If the responder accepts for a given (X,r), then he should also accept for any (X',r') if $X' \geq X$ and $r' \geq r$. A rejection would violate the theory.

Case 2-Comparison to a rejected offer

If the responder rejects for a given (X,r), then he should also reject for any (X',r') if $X' \leq X$ and $r' \leq r$. An acceptance would violate the theory.

In the same way, as long as we make the assumption that the proposer has a marginal rate of substitution of kindness for money is higher than the trade-off rate represented by the game (i.e., has indifference lines flatter than the constraint in Figure 2), we can place bounds on proposer behavior.[16] If the proposer sees that a given offer r is accepted for pie size X, than that proposer should not attempt to move NE on Figure 1. In other words, if X increases, the proposer knows that the previous offer r, as well as some lower offers r would be acceptable. A movement NW would support the theory whereas a movement NE would violate it.[17] If the pie shrinks then no offer can violate the theory—again, a stronger test of the theory might rule out such observations as inconclusive. Also, if a proposer sees that an offer r for pie size X is rejected, then a movement SW on Figure 1 would violate the theory, whereas a movement SE would support it. This leads to Proposition 2

-*Proposition 2 (for the proposer)*

Case 1-Comparison to an accepted offer

If the proposer sees that an offer r for (X,r) is accepted, then if $X' \geq X$, the proposer's offer r' for (X',r') should be $r' \leq r$. An offer $r' > r$ would violate the theory.

Case 2-Comparison to a rejected offer

If the proposer's sees that an offer r for (X,r) is rejected, then if $X' \leq X$, the proposer's offer r' for (X',r') should be $r' > r$. An offer $r' \leq r$ would violate the theory.

5.2 The Predictions of Alternative Theories

We compare the predictions of *reciprocal kindness* (Propositions 1 and 2) to those of three other theories. A stylized fact in Ultimatum bargaining is that the modal offer is 50% of the pie. We call this hypothesis (that individuals seek to split the pie in half) the *equal-split* hypothesis. Data in support of this hypothesis would imply that the mean of the empirical distributions of offers would not significantly differ from 50%. That is, the theoretical test distribution has its entire mass at a 50% offer. A weaker version of the equal-split hypothesis would allow for some randomness in the offers. Such randomness might generate, for example, a normal distribution of offers centered at 50% offers. The equal-split hypothesis would then predict that our empirical distributions are not statistically significantly different from a theoretical normal distribution of offers with mean=50%.

Ochs and Roth (1989) suggest that responders may demand a minimum percentage of the pie. This is referred to as the *minimum percentage* hypothesis. Under this hypothesis we would predict both that acceptance rates are invariant to the stakes of the game, *ceteris paribus,* and consequently that offer percentages for all pie sizes should be identical (and at the expected minimum threshold).

Finally, Slonim and Roth (1998) suggest a learning model whereby proposers will learn to make lower offers in higher stakes conditions if responders display lower rejection frequencies for higher stakes games. Again, high and low stakes conditions are subjective, but as the stakes increase, an assumption is that offer percentages will fall. This hypothesis implies that offers occurring in later rounds of the experiment will be lower percentage offers. Slonim and Roth randomly change ultimatum partners in each round, but proposers are allowed to play multiple ultimatum games of one pie-size. We do not duplicate their experimental design, but learning would still imply lower offers in later rounds controlling for the stakes of the game. We call this the *learning* hypothesis.

An unfortunate byproduct of the design in this paper is that there are many offers and responses that would be considered inconclusive for a strong test of the reciprocal kindness hypothesis. On the other hand, the data are still given the opportunity to support or discredit

Propositions 1 and 2 as well as the alternative hypothesis. The results of the experiments allow a strong test of 103 responder decisions and 41 proposer offers that either support or violate the reciprocal kindness theory (i.e., decisions that are **not** inconclusive), and we also compare results with those predicted by the alternative theories.

6. Results

In total, 20 ultimatum games were played for each pie size \$1, \$2, \$4, \$7, and \$15 for a total of 100 ultimatum games. The 40 subjects were undergraduate students recruited from economics classes at the University of Arizona, and they were not experienced in either the ultimatum or dictator games. Sessions lasted for about 45 minutes and the average payoff over and above a \$5.00 show up fee was \$12.98 with a high of \$18.25 and a low of \$4.00. Subjects did not know the number of rounds in the experiment, but they were recruited for an hour-long experiment.

The aggregate data is summarized in Figure 3, which plots the amounts offered for each of the five pie sizes. Rejection information is not included in these figures. Rejections, as a percentage of the 20 offers made for each of the pie sizes, were as follows: 10% (2/20), 10% (2/20), 5% (1/20), 5% (1/20), and 15% (3/20) for pie sizes \$1, \$2, \$4, \$7, and \$15, respectively. The mean percentage offer that was rejected across all 5 pie sizes was 27% of the pie.

We first examine the alternative hypothesis by starting with the equal-split hypothesis. We examine the equal-split hypothesis by first testing whether or not the mean offer in our empirical offer distributions equals 50%. A nonparametric signed-rank test on the offer distribution of each distinct pie size easily rejects the null hypothesis that the mean offer=50% in favor of the alternative that mean offers are less than 50% ($p<.01$ for all 5 tests). Alternatively, we can test our empirical distribution against a theoretical standard normal distribution centered at 50% offers.[18] We use a Mann-Whitney U-test in comparing each of our offer distributions to the theoretical distribution. We can reject the null hypothesis that the $1, $2, $7, and $15 offer distributions are each equal to the test distribution (p=.09, .10, .02, .08, respectively).[19] Only for the $4 pie could we not reject the null hypothesis (p=.43). In all fairness, this result for the $4 pie was entirely due to one outlier offer of 90% of the pie. If we were to exclude this outlier we would reject the null hypothesis of equal distributions for the $4 pie as well. What these tests confirm is that offer distributions are skewed (see Figure 3), and mean offers are less than an equal split of the pie. This is consistent with existing ultimatum research and, as expected, the rejection of the equal split hypothesis points towards more strategic calculations on the part of proposers.

We next discuss the minimum percentage hypothesis. Data in support of this theory would imply that offer percentages are identical for all different stakes conditions. The mean percentage offer was between 41% and 43% for all games. Mann-Whitney U-tests are used to test the null hypothesis that the means of different pairs of distributions are different. In all cases we fail to reject the null hypothesis (p>.10 in all 10 comparisons of the 5 different pie-size distributions). There are relatively few rejections with which to examine how acceptance percentages are affected by the stakes of the game, but a probit estimation of the responders' acceptance equation (see Table 1—to be presented shortly) suggests an insignificant probability of acceptance response to the pie size. These results are contrary to the result reported in Slonim and Roth, but their experiments involved both higher stakes and a wider range of pie sizes. Nevertheless, it is of interest that, for our (smaller) range of pie sizes, the data thus far support the minimum percentage hypothesis.

To examine the learning hypothesis we aggregate the data by round of play. Each round of play consists of data from ultimatum games of all five pie sizes. In Figure 4 we can see that for the later rounds offer distributions appear more left-skewed, which would support the learning hypothesis. The difference in distributions is insignificant for all pair-wise comparisons using the Mann-Whitney 2-sample test ($p>.10$) *except* for the comparison of offer distributions from rounds from 1 and 5 ($p=.08$). This seems to offer some support for a significant learning effect when comparing the first and last rounds. However, the distributions tested from Figure 4 do not control for pie size. Any learning effect is therefore confounded with any pie size effects. A parametric regression equation for the determinants of a proposer's offer finds an insignificant round effect when controlling for the size of the pie. The results of this estimation are shown in Table 2 (to be discussed shortly). The weight of the evidence leads us to reject the learning hypothesis for this data set.

Data in support of the learning hypothesis is found in Slonim and Roth and Roth and Erev (1995). The learning hypothesis presupposes that proposers expect lower rejection rates for higher stakes games. Lower rejection rates are not present in our data set, though, and so the rejection of this hypothesis may also be a result of the range of pie sizes. We are inclined to believe that the range of pies *is* important, not just in a relative sense but also in an absolute sense. As such, we now believe that the predictions of both the learning hypothesis and the minimum percentage hypothesis are sensitive to the size of the payoffs—even among salient amounts of cash.

We begin analyzing the reciprocal kindness hypothesis by looking at the responders' behavior. Since the theory does not place any restrictions on the *ordering* of the responders' rejection/acceptance decisions, we can compare the response for a particular pie size against the responses for all of the other pie sizes. Thus, with each responder making decisions on 5 different pie sizes, there are 10 total comparisons to be made for each responder. Of the 200 comparisons to make for all 20 responders, there was not a single violation of Proposition 1 for responders. The data further stands up to a strict look at the 103 theoretically conclusive responses (97 responses can be categorized as inconclusive).[20] Of the 103 conclusive responses, **all 103** support the reciprocal-kindness theory using the criteria of Proposition 1. In other words, there is *not a single case* in which a responder's response pattern violated the theory.[21] This is an especially salient result given the "noise" that is often considered an issue in experimental data. Granted, the responders have the luxury of behaving under the certainty of the kindness signal that is given to them, but this is nonetheless evidence in strong support of the theory for the responders.

We also estimate a probit model which assumes that the probability of a responder acceptance is a function of the size of the pie (*Pie*), the current offer percentage (*Offer*), and the difference between the current offer percentage and the previous round offer percentage for the responder (Δ*Offer*). This probit model includes the variables of interest from Proposition 1. Such an estimation uses the final 4 rounds of data for all responders (N=80), but a drawback is that it analyzes some responses that are theoretically inconclusive according to Proposition 1. Nevertheless, it offers an additional analysis of the data that that is not possible in the typical ultimatum game where subjects play only once, or where they bargain over the same sized pie. The results of the probit estimation are found in Table 1 below, and they imply that the offer appears to be more important to the responders than the size of the pie.

INSERT TABLE 1 HERE

Both of the coefficients on *Offer* and Δ*Offer* are statistically significant in raising the probability of an acceptance, while the coefficient on *Pie* is statistically insignificant.[22] The marginal effects indicate that an offer 10% higher would increase the probability of acceptance by about 3%, while an increase in Δ*Offer* of 10% (e.g., an improvement on what the responder was offered in the previous round) would also increase the probability of acceptance by about 3%. Two comments follow from Table 1. The insignificance of the variable *Pie* seems counter to the predictions of reciprocal kindness, but Rabin suggests that fairness payoffs will dominant monetary payoffs for low amounts of money. Such a result is then consistent with reciprocal kindness when kindness payoffs dominate, and it is also consistent with our previous analysis which indicated that the increase in pie size might not be considered "large". Also, the direction and significance of the effects of the variables is probably of more importance than the magnitude of their effects. The model would predict that 50% offers stand only a 15% chance of acceptance. We should therefore proceed with caution in interpreting the results of such probit equations.[23]

While responders behave in strong support of the theory, the proposers are somewhat less conclusive. First, there are fewer comparisons to analyze for the proposers. All combinations of proposals cannot be compared as was the case with the responders, and only the proposals for the 2nd-5th rounds yield usable data (since the first round gives no previous round information to the proposers). For rounds 2-5 the proposers' offers in each round were compared to the previous round's offer that had been made to the responder with whom they were currently matched. As such, there are 4 comparisons to be made for each proposer, which yields a total of 80 proposals to evaluate based on the criteria of Proposition 2. Of these 80 proposals, 12 violate the theory. For our stronger test of the theory, we note that 39 comparisons can be classified as inconclusive, implying that the theory has a success rate among conclusive proposals of 71% (29/41).

There does appear to be more support than lack of support for the theory, but the more uncertain nature of the proposers' decision-making environment leads to weaker results than those of the responders. We can perform a simple binomial test on the data where the probability of success is the probability of an observation in support of the theory. Assuming that the probability of success and failure are identical we can reject the null hypothesis that 29 out of 41 conclusive observations in support of the theory occurred by chance (p=.00).[24]

We also estimate a random effects model where the proposer's offer percentage is assumed a function of a constant, a dummy variable for whether or not the responder with whom he is now matched accepted in the previous round ($Accept_{t-1}$), the offer percentage made in the previous round to the proposer's current responder ($Offer_{t-1}$), the round of play (*Round*, to capture any possible linear learning effect), and the size of the pie (*Pie*).[25] The results of the GLS estimation are in Table 2. From Table 2 we see that a proposer's percentage base offer in round one of a $1 pie is about 33% of the pie, and is then statistically significantly increased by $Offer_{t-1}$

INSERT TABLE 2 HERE

and marginally significantly decreased by *Pie.* The magnitude of the coefficient of $Offer_{t-1}$ indicates that if a proposer's partner was offered, for example, 40% of the pie in the previous round, then the proposer will offer 12% more of the pie. Such an increase is on top of the standard percentage offer for a given round and pie size. It seems clear that proposers use past offers as a gauge for current offers when such information is available, but whether or not the past offer was accepted is not important (i.e., insignificance of the coefficient on $Accept_{t-1}$).

The coefficient on *Pie* is marginally significant and negative (p=.06). Its significance would weaken support of the minimum percentage hypothesis. The magnitude of the coefficient suggests that increasing the pie from its smallest ($1) to its largest ($15) would decrease the offer percentage by 5%. Taken together with the nonparametric tests that fail to reject the null hypothesis of differences in mean offers of all pie-size distributions, and the probit results from Table 1, we conclude that there is weak support for the minimum percentage hypothesis.

One might also view the coefficient on *Pie* as in support of the learning hypothesis. That the stakes of the game should decrease offers is, however, an assumption of the hypothesis, not the hypothesis itself. The insignificant (positive) coefficient of *Round* implies that proposers do not significantly alter their offer percentages as they learn to play the ultimatum game, ceteris paribus. The learning that is substantiated in Roth and Erev (1995) and Slonim and Roth (1998) can probably be attributed to repeated play of the ultimatum game of the same pie size. In their experiments individuals played multiple rounds of the same pie-size ultimatum game prior to the stakes being altered. Repeated play (of the same pie size) gives proposers more time to search for the rejection threshold of the responders. It is not necessarily the repeated play of the ultimatum game that proposers learn from, but rather repeated play *of a particular* pie size.

The coefficient on *Pie* also supports the reciprocal kindness hypothesis. As the stakes of the game increase, percentage offers decrease. Even so, the individual-level data reveal that when proposers play a larger stakes game against a responder who just accepted a given percentage offer for a smaller pie, many simply offer the same percentage of the pie. Even if they believe that the responders would be willing to accept a smaller percentage offer, the cost of search for the lower rejection point is apparently not worth the marginal gain of the smaller offer. Finally, the resulting coefficient on $Accept_{t-1}$—statistically no different than zero—can be interpreted as in support of the reciprocal kindness hypothesis if proposers are risk averse as they form conjectures about the steepness of the rejection function in Figure 1.[26]

When discussing the risk aversion of proposers and the marginal gains of searching for rejection points, we should note that we are implicitly highlighting that Rabin's reciprocal kindness theory is still a theory of (expected) utility maximization. Roth et al. (1991) evaluates the behavior of proposers in a multicultural ultimatum study in part by calculating the offer that maximizes the proposer's expected payoff.[27] If for the 1$ pie, for example, 4 offers of $.25 cents were made (i.e., the proposer would keep $.75), and 3 were accepted by responders, then the proposer's expected earnings from offering $.25 cents could be ($.75)(.75)=$.56. Our data are more limited since we have 5 different pie sizes, but we can proceed with similar calculations once we first pool our data for each pie size separately.

For pie sizes $1, $2, $4, $7, and $15 the expected income maximizing offer is 43%, 38%, 38%, 38%, and 28%, respectively.[28] This supports the reciprocal kindness theory for proposers since the offer percentage that maximizes expected utility is a decreasing function of the pie size.[29] These percentages are merely suggestive, though, since we noted earlier in this section that the differences in distributions of offers across pie sizes are statistically insignificant (p>.10 in all comparisons of the 5 different pie-size distributions using the U-test). It is difficult to further comment on whether or not our proposers *learn* to play the expected utility maximizing outcome as in Roth et al. This is in part because, unlike this study, in Roth et al. subjects play 10 rounds of the ultimatum game and the size of the pie does not vary. Since Roth et al. uses one pie size for virtually the entire study, this affects the comparison of our results with theirs when we realize that changing pie sizes changes rejection thresholds—this creates somewhat of a moving target for our subjects. Nevertheless, we find that modal offers in the last two round of our experiments are closer to the utility maximizing offers for each pie size than they are in the first two rounds.[30]

7. Concluding Remarks

This paper presents an experimental design capable of generating data to test several theories of ultimatum bargaining behavior. Whereas most research to this point has concerned itself with the framing of bargaining decisions, rule-of-thumb theories (e.g., 50-50 splits or minimum acceptable offer theories, etc.), or alternating-offer multiperiod bargaining, the ultimatum game had not yet been used to test a theory of *reciprocal* kindness. The Rabin (1993) model of reciprocal kindness yields testable implications when varying the stakes in the ultimatum game. The data from a series of ultimatum games are analyzed and we compare the prediction of reciprocal kindness with an equal-split hypothesis, a minimum-percentage hypothesis, and a learning hypothesis.

The following qualifications should be mentioned. The data generated from our experiments can scrutinize the reciprocal kindness hypothesis, but the test is not the most powerful. The data that are conclusive can scrutinize Propositions 1 and 2 (and hence, the theory), but unfortunately about half the data generated is unusable. As a result, the regressions performed using all data are of a more general nature and do not necessarily offer the most clean test of the theory. Such limitations are inherent in certain settings, such as in trying to submit the Generalized Axiom of Revealed Preference to a test using consumption data (see Cox (1997)).

The data from 100 ultimatum games with different sized pies strongly support the Rabin model as applied to responder behavior. Fully 100% of the conclusive data are consistent with

Proposition 1 for the responder. Proposer behavior more weakly supports the theory assuming proposers are risk averse since 71% of the conclusive data support Proposition 2. Somewhat less conclusive results with the proposer data might be expected given that proposers are at an information disadvantage in not knowing a responder's rejection point. Nevertheless, we believe there is support for the proposition that bargainer utility is determined by both money and fairness as suggested by the Rabin model. While not statistically significant, the direction of proposer behavior also suggests that the expected utility maximizing offer of proposers is a decreasing function of the pie size—this is an implication of the Rabin model. Additional regression analysis reveals that the responders care more about the percentage offer than the size of the pie and, for proposers, the history of past offers and (marginally) the size of the pie are important in determining current round offers. All data taken together—parametric tests, nonparametric tests, and tests of Propositions 1 and 2—tend to support the reciprocal kindness theory, even though the support is somewhat weaker for proposer behavior.

Alternative theories of ultimatum behavior are also examined. The data presented here do not support the equal-split hypothesis or the learning hypothesis. While we reject the learning hypothesis for our specific design, it may be that repeated play of the same pie size is what generates learning behavior. Rejection of the equal-split hypothesis is consistent with reciprocal kindness in that offers are strategic, and the fact that the modal ultimatum offer is 50% is more due to risk aversion by proposers than to altruistic motives. The data weakly support the minimum percentage hypothesis, implying that responders care more about fairness and so demand a minimum percentage of the pie (between 30% and 50%). Others have rejected the minimum percentage hypothesis for larger pie-size bargaining behavior.

Considering this study along with other ultimatum research, the body of evidence suggests that for smaller stakes games fairness dominates monetary payoffs, while for larger stakes games money dominates fairness—a fact which itself is support for the reciprocal kindness theory. Therefore, while proposers cannot make low offers without risking rejection, our results suggest that proposers maximize expected utility by lowering offers as the stakes rise.

Such results are not merely of interest to the bargaining researcher. Ultimatum bargaining is considered the building-block of more complicated bargaining environments. These results imply that perceptions of fairness and desirable outcomes are *not* independent of the stakes of the game. Final offers in Union and contract negotiations are presumably higher-stakes games than bargaining over a the price of a basket at a flee-market. Our results predict that outcomes will appear more fair or equal split from a money (or surplus) standpoint at the flee-market than in the contract negotiation. These results direct us towards collecting naturally occurring empirical data as a first step towards examining the applicability of the ultimatum game to well-known bargaining environments.

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ENDNOTES

[1]Another pie-splitting game that has been extensively studied is the dictator game. Here, the responder is not even given the opportunity to reject an offer, but rather is forced to accept whatever the proposer offers. Again, fairness considerations are often mentioned in attempting to explain nonzero "gifts" to the receiving party, but this paper will focus on the ultimatum game.

[2]Hoffman et al. (1991) further eliminate some positive offers by employing a "double-blind" procedure in the dictator game that guarantees subject anonymity even to the experimenter. This suggests that still some more positive offers may be strategic responses to unintended procedural features. It also suggests that some subjects may care more about the opinions of a third party that they do about the person with whom they are paired.

[3] More specifically, Fehr and Tougareva conduct experiments in which earnings for a two hour session were between two and three times the subjects' monthly income.

[4] Bolton is more a theory of "selfish" kindness where utility is defined for player *j* as $U_j = m + r(i)$. Here, *m* represents monetary earnings, and *r* represents relative money earnings as a function of Bolton's relative money index *i*. This relative money index implies that individuals care about earnings disparity only in as much as it affects their own utility.

[5] Such psychological games are defined in Geanakoplos, Pearce, and Stacchetti (1989).

[6] Technically speaking, Rabin's model is not intended for application towards sequential or asymmetric games. This does not imply, however, that it will not predict well in the simple bargaining institution of the ultimatum game. We might similarly claim that since the assumptions of the perfectly competitive model are almost never satisfied, the model is void of influence. However, it has been show by countless experiments using varying trading institutions that the model has incredible predictive powers in many institutions that fail to satisfy the model's most basic assumptions.

[7] Specifically, the proposer (player 1) still maximizes utility described by (2) while the responder (Player 2) maximizes $U_2(a_2, b_1, c_2) = \pi_2(a_2, b_1) + \tilde{f}_1(a_1, c_2) \cdot [1 + f_2(a_2, b_1)]$. That is, by seeing the signal given by the proposer we have $b_1 \equiv a_1$. While appearing to give the respondent an advantage in not having to form a belief of the proposer's strategy, this information is known to the proposer. The equilibrium description of the game is still given by Definition 3 above.

[8] As we will see, the equilibrium condition amounts to the proposer finding the smallest offer that he can get away with without it being rejected. At the same time, the responder compares the utilities, given the offer, of accepting and rejecting the offer. This permits acceptance or rejection of *any* offer depending on the weight α in the utility function.

[9] Bolton (1991) also includes some limit results. Among those, a condition similar to condition c) above is that as the size of the pie grows, the value of the first period offer (his model is a two-period bargaining game) must increase. This is similar, but not identical, to limit condition (c) since the value of the offer in our model must increase in order that the percentage offer of an ever-increasing pie remain constant

[10] Straub and Murnighan (1995) elicit minimum acceptable offers for different size ultimatum games. Their aggregate results suggest that acceptable percentage offers do decrease with large, albeit hypothetical, pies of $1,000, and $1,000,000.

[11]Technically, limit results a) and b) could be manipulated by an experimenter, but not without either removing the choice from the proposer, or by eliminating the proposer altogether, thus defeating the purpose of a bargaining game.

[12] Notice that even in the event the an offer of $0 is accepted, this is still consistent with this formulation of fairness equilibria when α=1. In this case, only money matters and accepting is a weakly dominant strategy.

[13]We should not completely dismiss the possibility that the proposer has more traditional convex indifference curve representing diminishing marginal utility for money and fairness. Results given such preferences would, however, be empirically indistinguishable from those where linear preferences exist and the rejection point is unknown.

[14] Moreover, since players know nothing about any of their opponents, we have no reason to believe that subjects alter their fairness and monetary payoff weights across ultimatum games.

[15] Brandt and Schram (1996) develop the "strategy method" for voluntary public goods contributions and the method could also be applied to ultimatum bargaining. With this method, a complete response function could be elicited from each responder. This allows the researcher to gather a richer data set. It has been pointed out, however, that its use changes the game by requiring trembling hand perfection in place of subgame perfection.

[16] This is a fairly innocuous assumption since if a proposer's indifference lines were steeper than the constraint, the whole pie should be offered--an event that was never observed. The other possibility is that their slopes are the same, but this would imply that the proposer is indifferent

among any r offer which would seem to contradict the stylized fact in ultimatum games that most offers are for 50% or less of the pie.

[17] Actually, a stronger test of the theory would require the offer be necessarily smaller, not just less than *or equal to* the previous offer. If proposers are risk averse, though, it would be (expected) utility maximizing to make the same percentage offer given a high enough degree of risk aversion.

[18] We use the standard normal statistical tables to objectively generate our test distribution.

[19] Categorizing the data here (as is presented in Figure 3) is preferred to using exact percentages for ranking. This helps correct for any differences in offer percentage due to the displayed tendency to make offers in increments of $.10 (even though allowable offers were in increments of $.01).

[20] All individual-level data is available from the author by request.

[21] That is, no one accepted an offer r for pie X yet then rejected $r' \geq r$ for $X' \geq X$. Similarly, no one rejected an offer r for pie X yet then accepted $r' \leq r$ for $X' \leq X$.

[22] *Offer* and Δ*Offer* are collinear to some extent with a simple correlation of .52. However, the condition number for these two variables is 1.01, indicating that the collinearity is not significant.

[23] The inclusion of a constant term in the probit equation would perhaps solve the problem in terms of the magnitude of the effects. However, it is omitted out since there is no *a priori* reason to believe that 0% offers of a pie X=$0 would ever be accepted.

[24] A even stronger test of the theory would require **strict** inequalities from Proposition 2. That is, if a responder accepts for (X,r), then for a strictly larger pie, the proposer should strictly reduce r. With this strongest test, only 20 of 41 conclusive proposals support the theory. Here

the binomial test cannot reject the null hypothesis that this occurs by chance alone (p=.56). This weaker result is more likely a result of risk aversion by proposers since trying to lower the offer percentage and locate the exact boundary of the responder's acceptance/rejection region is not worth the risk of rejection.

[25] The random effects model is support by a Hausman test. Such a model assumes that an individual-specific error-term captures the individual specific effect of each proposer. A fixed effects model, while a rejected specification, yields qualitatively similar results for all variables.

[26] This data is in general support of Bolton (1991) as well—as it would apply to a single-period game. Bolton would suggest that it is not reciprocal kindness, but rather inequality aversion that drives the results. As such, if an offer percentage is too low and a responder rejects, it is because only by rejecting and equalizing payoffs at $0 can the responder avoid the inequality in outcomes.

[27] The Roth et al (1991) study involves playing an ultimatum game of the same size for 10 rounds. The authors investigate whether or not by round 10 the proposers are on average making proposals that would maximize expected earning which are calculated from the data pooled over all 10 rounds.

[28] These calculations are from the categorized data presented in Figure 3, and we report the midpoint of the category that maximizes expected earnings. We have eliminated from the comparison expected earnings maximizing offers generated by only one offer since with one offer the acceptance rate varies extremely (either 0% or 100%).

[29] This offer would also maximize expected earnings since it can be shown that the proposer always seeks to offer the lowest amount possible and still have the offer accepted.

[30] Specifically, in the last two rounds the average proposer offer for each pie size was within 5% of the utility maximizing offer in 5 out of 8 cases (4 sessions were run, so that the last two rounds provides 8 sets of offers). For the first two rounds, this was true in only 1 out of 8 cases.

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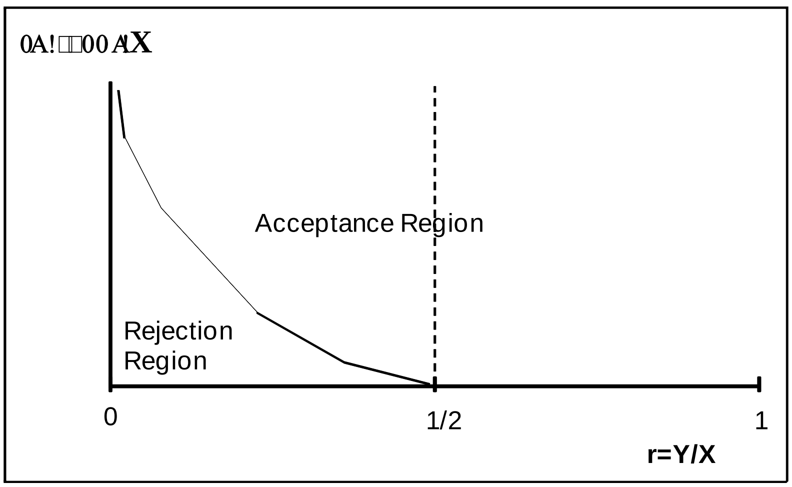

Figure 1: The Reciprocal Kindness Acceptance Function

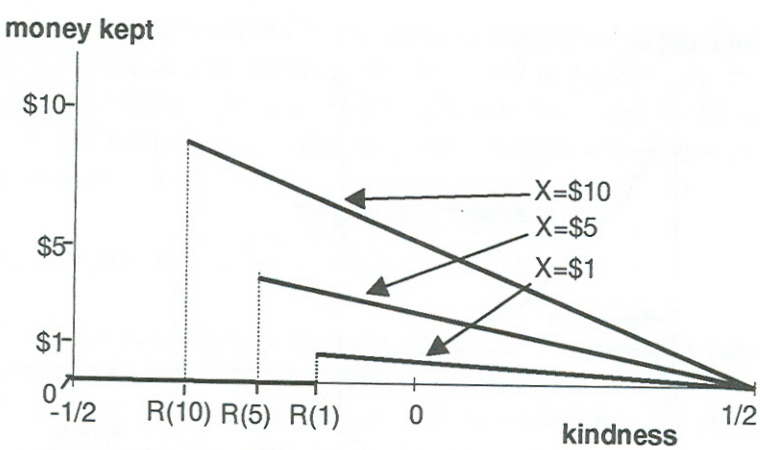

Figure 2. Constraints for different sized pies, X.

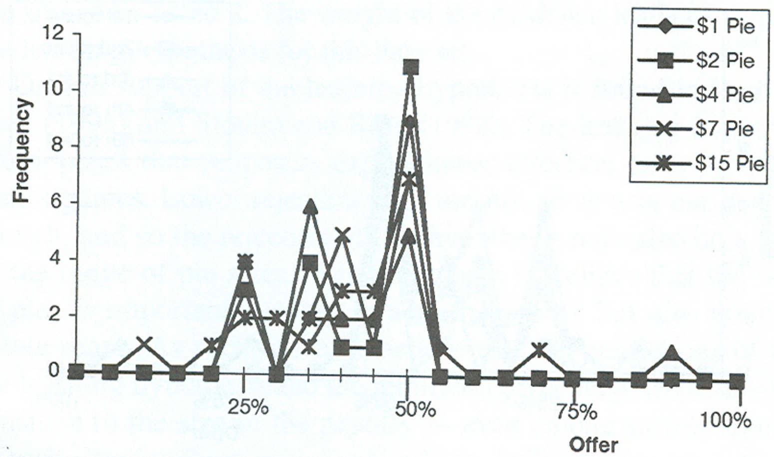

Figure 3. Permanent offers for different pie sizes. Offer frequencies grouped by Offer percentage (e.g., 20–25% or 40–45%). Axis labels refer to low offer in category so that the 25% mark is for the 25–30% category. A separate group is used for all 50% offers.

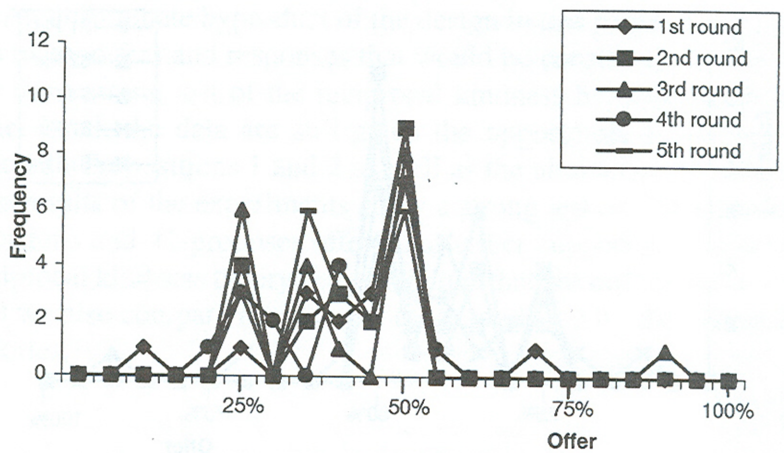

Figure 4. Percentage offers for different rounds of play. Offer frequences grouped by Offer percentage (e.g., 20–25% or 40–45%). Axis labels refer to low offer in category so that the 25% mark is for the 25–30% category. A separate grouping is used for all 50% offers.

TABLE 1

Results of Probit Estimation of Responder Acceptance Equation Dependent variable=1 for responders who accepted a proposal **Variable**	 **Coefficient (p-value)**	 **Marginal Effect**
Pie	-.06 (.22)	.00
Offer	5.83 (.00)*	.29
Δ*Offer*	5.56 (.01)*	.27

*Indicates statistical significance at the 1% level.

TABLE 2

Results of Random Effects model (GLS) estimation of Proposer Offer Equation Dependent variable=Proposer's Offer Percentage, r. N=80, R^2=.09 **Variable**	 **Coefficient (p-value)**
Constant	.34 (.00)*
$Offer_{t-1}$ (from a different proposer)	.30 (.01)*
$Accept_{t-1}$	-.04 (.31)
Round	-.002 (.83)
Pie	-.004 (.06)

*Indicates statistical significance at the 1% level.